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From Actuarial Education and Research to Practice: Long and Variable Lags

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The brief from the editor of *Expanding Horizons* for this essay was to give some personal reflections on how actuarial education and research influence actuarial practice. "Education and research" is an example of a conjugate metonym: two words linked together so as to imply that each is inseparable from the other (like "true and fair" or "rest and recuperation" or "drink and drugs"). I prefer to deny the metonym and consider each term separately, using the construct of mutual influence. That is, actuarial research both *influences* and *is influenced by* actuarial practice. The same is true for actuarial education. But it is true for each in different ways, and with long and variable lags.

ACTUARIAL RESEARCH

Actuarial research is influenced by practice insofar as research typically starts from a problem or observation from practice. I say "typically" because this pattern is not universal: some "blue sky" research starts from an idea that no practitioner has ever considered. But in an applied discipline, a practical problem is the typical starting point. It does not follow that either the questions posed or their answers must be immediately accessible and attractive to practitioners. This is for two reasons. First, answers that are already accessible do not require research! Second, most research is to some degree a critique of current practice, either because it casts new light on what practitioners are doing or because it suggests better ways of doing it.

Actuarial research influences practice with long and variable time lags, which reflect contingencies such as the proximity of the researcher to practitioners with sufficient mathematical inclinations, as well as language, location and style of publication. A few examples will illustrate this. In 1903 the Swedish actuary Filip Lundberg set out all the essentials of collective risk theory,[1] but because he wrote in Swedish, the ideas were not really recognized until Harald Cramér presented them in English in 1930.[2] Even then, they were largely ignored by British actuaries for another 50 years. Redington's 1952 breakthrough concept of immunization was published in a British journal and hence quickly assimilated by British actuaries,[3] but it was largely ignored by financial economists and bond market practitioners for another 30 years. Sklar invented the copula in 1959,[4] but perhaps because he had no direct connections to the actuarial world, it was another 40 years before Li proposed an application in risk management.[5]

These examples suggest that even the most important new ideas are often initially discounted by practitioners and require repeated presentation over time in a variety of formats and venues before they influence practice. This has also been my experience with my own concept of "loss coverage." I make no claim that this idea is comparable to the contributions of the aforementioned authors. But because this is a personal essay, I shall use its history to illustrate the origination and development of new ideas.

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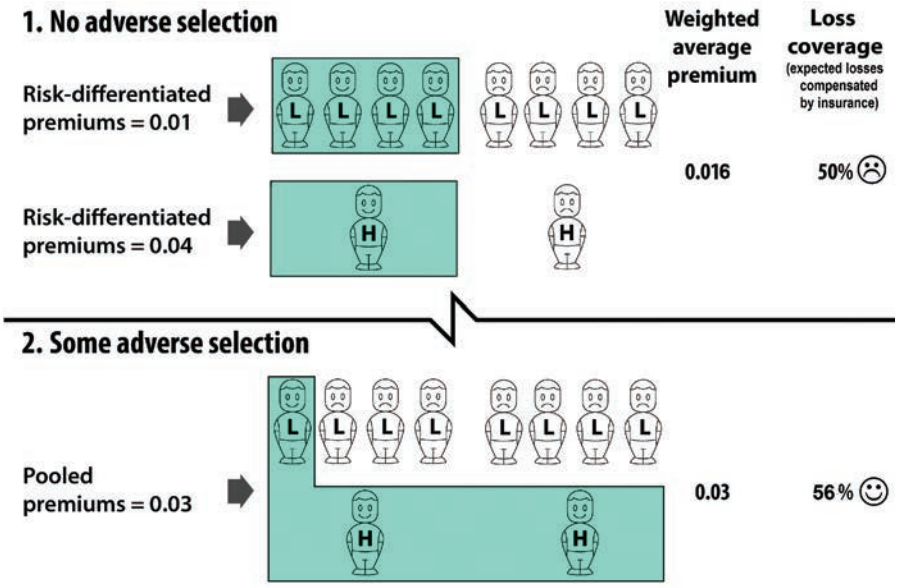
LOSS COVERAGE

Regulatory restrictions on risk classification (e.g., genetics, gender) are increasingly common in personal insurance markets. Although such restrictions can help to meet social objectives, they can also lead to adverse selection. This is usually seen as a problem, both for insurers and for society. The concept of loss coverage represents a partial counterargument: it suggests that contrary to orthodox wisdom, some adverse selection can make insurance work better for the population as a whole.

The concept of loss coverage can be illustrated by a toy example. To provide context, it helps to think of life insurance, where we typically observe a majority of "standard" lives and a small number of much higher risk lives (say with a genetic predisposition to illness).

Consider a population of just 10 lives with two alternative scenarios for risk classification. First, risk-differentiated prices are charged, and a subset of the population buys insurance. Second, risk classification is banned, leading to adverse selection: a different (smaller) subset of the population buys insurance. Assume that all losses and insurance cover are for unit amounts (this simplifies the presentation, but it is not necessary).

Figure 1
Alternative Scenarios for Risk Classification of a Sample Population



Source: Guy Thomas, *Loss Coverage: Why Insurance Works Better with Some Adverse Selection* (Cambridge, UK: Cambridge University Press, 2017). Reprinted with permission.

The two scenarios are shown in the upper and lower parts of Figure 1. "H" indicates high-risk participants (probability of loss 0.04), and "L" indicates low-risk participants (probability of loss 0.01). In each scenario, the shaded area over some of the participants denote the risks covered by insurance.

In Scenario 1, risk-differentiated premiums are charged. Higher and lower risk groups each face a price equivalent to their probability of loss (an actuarially fair price). The demand response of each risk group to an actuarially fair price is the same: exactly half the members of each group buy insurance. The shading shows that a total of five risks are covered.

The weighted average of the premiums paid in scenario 1 is $(4 \times 0.01 + 1 \times 0.04)/5 = 0.016$. Since higher and lower risks are insured in the same proportions as they exist in the population, there is no adverse selection. The expected losses compensated by insurance for the whole population, which I call the "loss coverage," can be indexed by

$$\frac{(4 \times 0.01 + 1 \times 0.04)}{(8 \times 0.01 + 2 \times 0.04)} = 50\%.$$

In scenario 2, risk classification is banned, so insurers have to charge a common "pooled" premium to both higher and lower risks. Higher risks buy more insurance, and lower risks buy less (adverse selection). The shading shows that three risks (compared with five previously) are now covered. The pooled premium is set as the weighted average of the true risks, so that expected profits on low risks exactly offset expected losses on high risks. This weighted average premium is $(1 \times 0.01 + 2 \times 0.04)/3 = 0.03$.

Note that the weighted average premium is higher in scenario 2, and the number of risks insured is lower. These are the essential features of adverse selection, which scenario 2 accurately and completely represents. But there is a surprise: despite the adverse selection in this scenario, the expected losses compensated by insurance for the whole population are now higher. The loss coverage in Scenario 2 is

$$\frac{(1 \times 0.01 + 2 \times 0.04)}{(8 \times 0.01 + 2 \times 0.04)} = 56\%.$$

I argue that scenario 2, with a higher expected fraction of the population's losses compensated by insurance, is superior from a social viewpoint to scenario 1. This superiority arises, not despite adverse selection, but because of adverse selection. So on the criterion of loss coverage, some adverse selection can be a good thing.

Where did this counterintuitive idea come from? Not from thinking about adverse selection in the abstract. Rather it came from thinking about a practical problem: the impetus in many countries in the late 1990s to ban insurers from asking about certain presymptomatic genetic tests. Actuaries and economists

argued against such bans because they would induce adverse selection, and initially I agreed; it seemed obvious that if adverse selection caused the market to disappear, this would not be helpful to anyone. But on more careful reflection, it occurred to me that if adverse selection was only moderate, this meant that *the people who need insurance more are more likely to buy it* (and the people who need it less are less likely to buy it). Looking at it this way, it was not obvious why a public policymaker should regard adverse selection as a disadvantage at all.

I articulated a primitive version of this idea in a few sentences in an article in 2001. At that time, the idea was undeveloped, and I did not fully understand its potential myself. Sometime later, I realized that the point could be made more clearly by toy examples where a quantity I called "loss coverage" increased under adverse selection, similar to Figure 1.[6] I then developed a more formal model.[7] At this point I had a nice theory and some affirmation through publication. But I could not see any way to develop it further until my colleague Pradip Tapadar, who has better mathematical skills than mine, took an interest in the idea. His contribution led to a refreshed research program that produced a doctoral thesis,[8] several more papers[9] and a book.[10]

The slow pace of development partly reflects the fact that I spend most of my time on investment, not actuarial research. But I think it also illustrates the general point that many new ideas take time to be fully understood, even by their originators, and also require presentation in multiple formats and venues to gain acceptance. The various formats are not just repetition, but (we hope) an upward trajectory, with successive presentations homing in on the core of an idea, as well as clarifying its weaknesses and limitations, and adapting it for maximum utility to different audiences.

So actuarial research both influences and is influenced by actuarial practice, but on different time scales. Actuarial research is influenced by practice insofar as it typically (albeit not invariably) starts from a problem in current practice. Actuarial research influences practice when research results are adopted by practitioners, though with long and variable time lags as illustrated in the examples given here.

ACTUARIAL EDUCATION

Much actuarial education, especially that provided by professional bodies rather than universities, is strongly influenced by practice. It is hard to see how it could be otherwise, given that professional associations are primarily concerned with certifying fitness for practice rather than with abstract ideals of intellectual exploration. We all become what we learn; so if you want to become an actuary, you need to learn what actuaries do.

But education heavily influenced by practice has two major drawbacks. First, the need for consensus about what is to be taught and the inevitable delays in updating syllabi mean that

the main influence is actually not *current* practice but *lagged* practice. Consequently, obsolescent topics tend to be given unjustified weight. The tables of commutation functions with which I became proficient in the late 1980s spring to mind; the same is probably true of the spreadsheet skills emphasized today. Second, education that is influenced by a lagged version of practice cannot cover developments that are not yet salient to practitioners. This can lead to emerging issues that are "close but different" to current practitioner interests being ceded to other professions.

An instructive example of the latter phenomenon from another profession is the loss of control by medical doctors of bioethics education in the United States.[11] Starting in the 1960s, new medical technologies such as heart transplants pointed to a need for ethical analysis of medical decision making. Senior doctors and medical societies were reluctant to engage with this development, which they saw as an unwarranted interference with the tradition of experience-based ethical judgments by individual clinicians (cf. "actuarial judgment"). To fill the gap, other researchers such as theologians and philosophers began to analyze medical decision making and call themselves bioethicists. By the early 1980s, when political and public pressure led to demands for ethics to be taught to medical students, there existed a substantial body of published work on medical decision making by bioethicists but very little by doctors. So medical ethics came to be taught using paradigms and textbooks developed by bioethicists rather than physicians. Many doctors were annoyed by these developments, feeling that it was absurd for non-doctors to preside over a field whose very title proclaimed that it was "medical"; they also felt that bioethicists tended to be too cautious about new technologies. But the doctors had only themselves to blame; their earlier disdain for the formal study of ethics had created the void that nondoctor bioethicists had filled.

In actuarial science, a close but different field that practitioners currently seem to disdain is risk management from the perspectives of individuals. Actuarial risk management focuses predominantly on the management of financial institutions. In the past quarter-century these institutions, often advised by actuaries, have pursued better risk management mainly through the expedient of offloading their risks onto individuals. Insurance guarantees and defined benefit pensions have been progressively withdrawn. Risk has been shifted toward individuals, but the locus of actuarial thought and effort has not. In the short term, it is probably more lucrative for actuaries to charge consultancy fees to institutions shedding risks than to individuals newly lumbered with risks. But in the long term, this focus on institutions (and an educational syllabus influenced by it) may lead to a similar outcome as for doctors and bioethics: if actuaries disdain to adopt the perspective of individuals, new types of advisers will develop the field. If advice to institutions remains lucrative, perhaps actuaries will not care; but will it still be lucrative when the last defined benefit pension fund has closed?

The shortcomings of education influenced by lagged practice can be mitigated by including in the curriculum some material inspired by research rather than practice. This type of research-led education is (or should be) an advantage for universities compared to other suppliers of actuarial education; the conjugate metonym of education and research makes more sense in a university context than anywhere else. At the University of Kent, we now teach the idea of loss coverage in postgraduate courses, even though it is antithetical to current practitioner views. Our hope is that this type of research-inspired education will (with a long time lag) be an exception to the prevalent pattern for actuarial education: it will influence practice rather than reflect a lagged version of it.

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INVESTMENT

The editor's brief also asked me to reflect on how actuarial education has influenced me as an investor. My initial reaction was along the lines of "not much": most of what I do as an investor seems closer to a blend of investigative journalism and epistemological introspection than to actuarial science. But on more careful reflection, I realized that the investment curriculum I followed early in my career probably did influence my development as an investor—or at least gave me implicit permission to try.

When I studied for the investment examinations in the United Kingdom in the late 1980s, a sizable minority of U.K. actuaries had been involved for some decades in active portfolio management. On the usual lagged-practice principle, the examination curriculum emphasized the comparative analysis of individual securities. The implicit message was that active portfolio management was a worthwhile endeavor, which probably encouraged me to make my own efforts in this direction. But after I qualified, in the early 1990s, actuarial involvement in active management in the United Kingdom declined. Again following the lagged-practice principle, the curriculum was changed in the late 1990s: material on comparative security analysis was removed and more emphasis given to the idea of efficient markets. The implicit message was that active portfolio

management was not worthwhile and that one would be foolish to try. Whatever the truth of the matter, we all have limited time and attention; to teach one thing is to exclude another. I am glad that I was taught that active investment is worth trying.

These changes, arguably contradictions, in the curriculum from one decade to the next reflect the truth that actuarial science is not a discipline with a distinctive core of unchanging principles. Instead, it seems to consist of "whatever mathematics is currently useful for managing long-term financial institutions," a toolkit of tenuously related techniques thrown together by accidents of history, like the communist country of Yugoslavia. This irreverent comparison sounds like a criticism, but it need not be. Many academic disciplines, especially the social sciences most proximate to actuarial science, seem more committed to methodology than to truth. The distinctive worldview of economists probably enhances their academic prestige, but it also fosters a striking obtuseness to ideologically dissonant facts. In the end, the lack of rigid ideology and methodology in the actuarial toolkit may be a strength rather than a weakness, at least as far as understanding the world and solving practical problems are concerned. ■

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ENDNOTES

1 Filip Lundberg, *Approximerad [ramstdllning av sannolikhets]unktioneD, AterfOrs~kring av kollektivrisker* (Uppsala: Akad. Afhandl., 1903).

2 Harald Cramér, *On the Mathematical Theory of Risk* (orig. pub. 1930), reprinted in *Collected Works of Harald Cramér* (Berlin: Springer, 1994), 601–78.

3 F. M. Redington, "Review of Principles of Life Office Valuations," *Journal of the Institute of Actuaries* 78, no. 3 (1952): 286–340.

4 A. Sklar, "Fonctions de répartition à n dimensions et leurs marges." *Publications de l'Institut de Statistique de l'Université de Paris* 8 (1959): 229–31.

5 D. X. Li, "On Default Correlation: A Copula Function Approach," *Journal of Fixed Income* 9, no. 4 (1999): 43–54.

6 R. Guy Thomas, "Some Novel Perspectives on Risk Classification," *Geneva Papers on Risk and Insurance* 32, no. 1 (2007): 105–32.

7 R. Guy Thomas, "Loss Coverage as a Public Policy Objective for Risk Classification Schemes," *Journal of Risk and Insurance* 75, no. 4 (2008): 997–1018; and R. Guy Thomas, "Demand Elasticity, Adverse Selection and Loss Coverage: When Can Community Rating Work?" *ASTIN Bulletin* 39, no. 2 (2009): 403–28.

8 Mingjie Hao, "Insurance Loss Coverage Under Restricted Risk Classification" (Ph.D. diss., University of Kent, 2017), *https://kar.kent.ac.uk/62465/1/209Thesis-MJHao.pdf*.

9 Mingjie Hao, Angus S. Macdonald, Pradip Tapadar and R. Guy Thomas, "Loss Coverage Under Restricted Risk Classification: The Case of Iso-elastic Demand," *ASTIN Bulletin* 46, no. 2 (2016): 265–91; Mingjie Hao, Angus S. Macdonald, Pradip Tapadar and R. Guy Thomas, "Insurance Loss Coverage and Demand Elasticites," *Insurance: Mathematics and Economics* 79 (2018): 15–25; and Mingjie Hao, Angus S. Macdonald, Pradip Tapadar and R. Guy Thomas, "Insurance Loss Coverage and Social Welfare," *Scandinavian Actuarial Journal* no. 2 (2019): 113–28.

10 Guy Thomas, *Loss Coverage: Why Insurance Works Better with Some Adverse Selection* (Cambridge, UK: Cambridge University Press, 2017).

11 Robert Baker, *Before Bioethics: A History of American Medical Ethics From the Colonial Period to the Bioethics Revolution* (Oxford, UK: Oxford University Press, 2013).

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